PHYSICS
CLASS XI

Time Period: 3 Hours] [Maximum Marks: 70

General Instructions:

- *All questions are compulsory.*
- *There are 30 questions in total. Questions 1 to 8 carry **one** mark each, questions 9 to 18 carry **two** marks each, questions 19 to 27 carry **three** marks each and questions 28 to 30 carry **five** marks each.*
- *There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks each. You have to attempt only one of the given choices in such questions.*
- *Use of calculators is not permitted.*
- *Draw neat and labelled diagrams in pencil wherever required.*
- *You may use the following values of physical constants wherever necessary:*
  Boltzmann's constant $K_b = 1.381 \times 10^{-11}$ J K^{-1}
  Avogadro's Number $N_A = 6.023 \times 10^{23}$ /mol

1. Name the term which has unit but no dimensions. (1)
2. Write the number of significant figures in each of the following measurements: (a) 1.67×10^{-27} kg (b) 0.02700 cm (1)
3. A new system of units is proposed in which unit of mass is α kg, unit of length is β m and unit of time is γ s. How much will 5 J measure in this new system? (1)
4. Sand is thrown on tracks covered with snow in hilly areas. Why? (1)
5. For uniform circular motion, does the direction of centripital force depend only on sense of rotation i.e. clockwise or anticlockwise direction? (1)
6. What is the amount of work done by (a) the earth's gravitational force in keeping the moon in its circular orbit around the earth? (b) an electron moving with half the speed of light in empty space free of all forces and for from all matters? (1)
7. Define radius of gyration. (1)
8. A wheel 0.5 m in radius is moving with a speed of 12 m/s. Find its angular speed. (1)
9. The length, breadth and thickness of a rectangular sheet of metal are 4.234 m, 1.005 m and 2.01 m respectively. Give the area and volume of the sheet to correct significant figures. (2)
10. A physical quantity p is related to four observables a, b, c and d as follows:

$$p = \frac{a^3 b^2}{\sqrt{c}\, d}$$

The percentage errors of measurements in a, b, c and d are 1%, 3%, 4% and 2% respectively. What is the percentage error in quantity p? If the value of p calculated using the above relation turn out to be 3.763 to what value should you round off the result? (2)

11. Draw (a) position time graph for an object for an object with negative velocity, (b) velocity time graph for motion with constant acceleration when motion is in negative direction with negative acceleration. (2)
12. State with reasons whether the following algebric operation with scalor and vector physical quantities are meaningful (a) adding any two scalors, (b) multiplying any vector by a scalor. (2)
13. A constant retardation force of 50 N is applied to a body of mass 30 kg moving initially with a speed of 18 m/s. How long does the body take to come to a hault? (2)
14. Show that the total momentum of an isolated system of interacting particles is conserved. (2)
15. Define average power and instantaneous power. Give its units and dimensional formula. (2)

16. State and explain theorem of parallel axis. (2)
17. The moment of inertia of a solid sphere about a tangent is $\frac{7}{5}MR^2$. Find its moment of inertia about its diameter. (2)
18. What is central force? Give any two important consequences for central force.

OR

"We cannot even raise a finger without disturbing the whole universe". Comment. (2)
19. Obtain the equations of motion for constant acceleration using method of calculus. (3)
20. The position of a particle is given by:

$$\vec{r}=(3.0\hat{i}-2.0t^2\hat{j}+4.0\hat{k})m$$

where *t* is in seconds and the coefficients have the proper units for $\vec{r}$ to be in metres? (a) Find the $\vec{v}$ and $\vec{a}$ of the particle? (b) what is the magnitude anf direction of velocity of particle at t = 2.0 s? (3)
21. Obtain the expression for motion of a car on a banked road. A circular racetrack of radius 300 m is banked at an angle of 15°. If coefficient of friction between the wheels of race car and the road is 0.2, what is the optimum speed of race car to avoid wear and tear on its tyres. (3)
22. State and prove Impulse – Momentum theorem. A batsman hits back a ball straight in the direction of the bowler without changing its initial speed of 12 m/s. If the mass of ball is 0.15 kg. Determine impulse imparted. (3)
23. Explain Newton's second law of motion terms of its components of force. Show that the force acting on a particle of mass *m* whose motion is described by $y=ut+\frac{1}{2}gt^2$ is *mg*. (3)
24. State Work – Kinetic energy theorem and prove it analytically.

OR

State and prove Work – Energy theorem for a variable force. (3)
25. Explain principle of moments. Derive its expression for a lever. (3)
26. Define angular momentum. Establish the relation between angular momentum and torque for system of particles. (3)
27. State Newton's law of gravitation. Show that for a two particle system gravitational force $\vec{F}_{12}=\vec{F}_{21}$. (3)
28. A projectile is fired at an angle θ_o with intial velocity v_o. Show that its trajectory is parabolic. Find the expression for (i) the maximum height reached, (ii) time of flight, and (iii) horizontal range of projectile.

OR

Define uniform circular motion. Derive expression for centripetal acceleration. What is the direction of centripetal acceleration. Express it in terms of angular speed. (5)
29. Obtain the expression for potential energy of a spring. Consider a typical stimulation with a car of mass 1000 kg moving with a speed of 18.0 km/h on a smooth road and colliding with horizontally mounted spring constant 6.25×10^3 N/m. What is the maximum compression of the spring?

OR

Define the terms elastic and inelastic collisions. A mass *m*, moving with a velocity *u*, collides head on with a mass m_2 at rest. If the collision is elastic obtain an expression for their velocity after collision. (5)
30. Discuss the variation of acceleration due to gravity with depth. Show that the value of *g* at height *h* is same as the value of acceleration due to gravity at depth *d = 2h*.

OR

Define satellites. Obtain the expressions for orbital velocity, time period and height above the surface of the earth. (5)